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BNL-77139-2006-AB

Microphysical Properties of Stratus/stratocumulus Clouds During the 2005 Marine Stratus/Stratocumulus Experiment (MASE)

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For Presentation at the
American Geophysical Union Fall Meeting
San Francisco, CA
Dec. 11-15, 2006

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ABSTRACT

Measurements of the properties of marine stratus/stratocumulus clouds were made over the Eastern Pacific Ocean during the month of July 2005 using the Department of Energy G-1 aircraft. Flights were conducted over a coastal site located at Pt Reyes National Seashore just north of San Francisco, and extended west over the Pacific Ocean to as much as 200 km offshore, and as far south as Monterey Bay. Clouds sampled during these flights extended from near the ocean surface to altitudes between 300 and 450 m, (msl). In all cases cloud top was associated with a strong temperature inversion that inhibited mixing with air from aloft. Liquid water content (LWC) increased nearly linearly from cloud base to cloud top in all of the clouds, but on six of the seven cloud flights, this increase was sub-adiabatic. Layer-averaged cloud droplet number concentrations (CDNC) ranged between 80 cm^{-3} and 400 cm^{-3} and were correlated with estimates of pre-cloud accumulation-mode aerosol number concentrations. On most flights CDNC increased with altitude above cloud base, in some instances by as much as 50%. The layer-averaged cloud droplet effective radius (r_e) generally increased with altitude above cloud base on all of the flights. Values of r_e ranged between 5 and 8 μm near cloud base to between 6 and 11.5 μm near cloud top; r_e decreased with increasing aerosol loading but the dependency was weak. The layer-averaged relative dispersion of the cloud droplet size distribution ranged between 0.2 and 0.8, in all cases decreasing with altitude above cloud-base consistent with droplet growth by uniform condensation. The relative dispersion was not a strong function of the CDNC or of the estimated pre-cloud aerosol concentration. Comparison of below-cloud CCN spectra to near cloud-base CDNC suggests that the maximum supersaturation achieved during cloud formation was low ($\%SS_{max}$~ 0.05-0.08). The low $\%SS_{max}$ was also consistent with differences between below- and in-cloud accumulation mode particle size distributions. Drizzle water content (d>50 μm) was generally low consistent with the small droplet sizes generally observed in these clouds. The one cloud layer in which significant drizzle was observed exhibited the highest values of r_e, and the smallest CDNC of any of the clouds sampled during the program.
